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CLEAN ROOMS - A SELECTED BIBLIOGRAPHY

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CONTENTS

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INTRODUCTION

The need for information on methods of achieving maximum sterilized conditions in space flight has resulted in a vast amount of technical literature on the subject of clean rooms. The Kennedy Space Center Library issued a bibliography on clean rooms (KSC RB-1, December 1965) compiled by Miss Tena Crenshaw and Mrs. Mary Kihm, listing materials available in the KSC Library.

The continued interest in contamination control using clean rooms, and the availability of material on the subject in the KSC Library have led to this expanded reissue of RB-1, prepared by Mrs. Ruth Perks. The bibliography is organized by category as follows:

1. Journals
2. Documents
3. Symposia
4. Books
5. Specifications and Standards

The compiler will welcome comments on the usefulness of this bibliography.

Journals

AACC TACKLES SPECIAL PROBLEMS IN CONTROLLING CONTAMINATION. Heating, Piping and Air Conditioning, Jul. 1964, 36: 121.

Short summaries are presented of papers given at the third annual technical meeting of the American Association for Contamination Control concerning laminar flow clean rooms and work stations. The discussions range from "hardware" cleaning to microbiological contamination.

Agnew, Boyd. APPLICATION OF AEROSPACE CLEAN ROOM TECHNIQUES IN PHOTOGRAPHIC LABORATORIES. Journal of the SMPTE, Feb. 1967, 76: 111-114.

A short history of clean room development and how it has been applied to photographic laboratories is given. How existing darkrooms can be converted into clean rooms by applying laminar-flow equipment in modular form is shown.

Austin, Philip R. OBSERVATIONS ON LAMINAR FLOW CLEAN BENCH MARKET. Air Engineering, May 1967, 9: 20-21, diagrs.

The factors involved in the growth of the clean bench market are reported, and some future demand projections are given.

Austin, Philip R. 'PEOPLE-GENERATED' CONTAMINATION: AUSTIN CONTAMINATION CONTROL INDEX: HOW IT WORKS. Contamination Control, Jan. 1966, 5: 11, 15, 16, 19, diagrs.

A method of predicting personnel-generated contaminant loads, based on numbers of personnel and their activity in the room, is described.

Austin, Philip R. STATE OF THE ART. Contamination Control.

This regular feature in each issue of Contamination Control deals with various aspects of clean room design and operation.

Austin, Philip R. U-HEPA FILTERS. Air Engineering, Apr. 1966, 8: 33.

Comments on the need and availability of U-HEPA filters.

Journals (continued)

Blain, Ray. EFFICIENT DUST CONTROL NEEDED WHERE ELECTRONIC EQUIPMENT IS OPERATING. Air Engineering, Jan. 1966, 8: 17.

Miniature clean rooms and gray rooms are offered as solutions to the dust control problem in electronic equipment operating areas.

Bolasny, Robert E., and Pearsall, Duane D. CONTROLLING STATIC IN THE CLEAN ROOM. Contamination Control, Sep. 1966, 5: 17, 18, 20-22.

Because of the many nonconductive surfaces, a clean room is highly susceptible to static generation. Methods of controlling and neutralizing static are discussed.

CLEAN ROOM COMMUNICATOR. The Journal of the American Association for Contamination Control, Sep. 1965, 4: 21.

At TRW/Space Technology Laboratories, the costly problem of communicating with clean room personnel was solved by installing a "Talk-Thru" window.

THE CLEAN ROOM GOES MOBILE. Research/Development, Jul. 1963, 14: 14-16.

Matthews Research, Inc. has manufactured a unique work station called a "White Bench." In many ways, the bench can actually be considered a mobile clean room in miniature.

"CLEAN ROOM" KEEPS DUST OFF MATERIALS BEING LAMINATED. Electrical World, 24 Apr. 1967, 167: 43, illus.

Describes the design and operation of clean room used to prevent contamination of flexible laminated materials. Materials are pumped into the room rather than carted.

CLEAN ROOMS FOR ENVIRONMENTAL CONTROL. Westinghouse Engineer, Jan. 1963, 23: 32.

Westinghouse Corporation's experience in the clean room field has been consolidated, and engineers are performing a coordinated service for anyone who needs a clean room. Engineers perform studies of individual requirements, design the rooms, make recommendations for all equipment, and complete installation of the structure.

Journals (continued)

CLEAN ROOMS NEED AIR THAT'S CLEANED AND PRESSED. Mill and Factory, Feb. 1965, 76: 72.

At the Electronic Specialty Company plant, where delicate instruments and components for precision gyros are manufactured, a better way was found for controlling instrument air.

COILS WOUND IN CONTROLLED ENVIRONMENT. Electrical World, 12 Dec. 1966, 166: 91, 94, illus.

This newsnote describes a clean room used in a coilwinding operation.

CONTAMINATION NEWSLETTER, Ann Arbor Science Publishers, Inc.

This monthly newsletter contains notes on developments in clean room technology and in contamination control.

Cooper, D. R., et al. MIL-STD-1246A: WHAT'S NEW IN IT? Contamination Control, Jan. 1967, 6: 10-12, 14, 15, 23.

"The proposed MIL-STD is expected to meet the primary need for placing contamination control requirements on DOD procurements." Author

Cown, William B., and Kethley, Thomas W. DISPERSION OF AIRBORNE BACTERIA IN CLEAN ROOMS. Contamination Control, Jun. 1967, 6: 10-14.

"Gives a description of the patterns of dispersion of airborne bacterial particles caused by the various ventilating procedures employed in clean rooms." Author

Emerson, Charles. TRANSMISSIONS GO SPOTLESS. American Machinist, 16 Jan. 1967, 111: 108-110.

A gray room used for assembling transmissions under "squeaky-clean" conditions is described. Information on employee training and indoctrination in cleanliness techniques is included.

Journals (continued)

Ernst, Robert R., and Kretz, Albert P. COMPATIBILITY OF STERILIZATION AND CONTAMINATION CONTROL WITH APPLICATION TO SPACECRAFT ASSEMBLY. The Journal of the American Association for Contamination Control, 1964, 3: 6 p., diagrs.

The compatibility of efforts to eliminate dust and the microbial population in the same areas is discussed. Problem areas are examined and tentative solutions offered.

FIST-SIZE "CLEAN ROOM." Compressed Air Magazine, Apr. 1967, 72: 12, illus.

Describes an unusual technique for producing ultraclean, 10-micron wire cloth filter assemblies for the Sidewinder missile launcher. The filter is assembled while sealed in a plastic bag.

Goodrich, Edward O. REPORT ON A LAMINAR FLOW SURGICAL FACILITY. Contamination Control, Sep. 1966, 5: 25-29, illus.

Startlingly low particle counts are obtained during operations from a modified counter held close to the surgical wound in an operating environment washed with horizontally flowing laminar air from high efficiency filter modules.

Graetz, G. M. LEAK TESTING HEPA FILTERS FOR CLEAN ROOM USE. Contamination Control, Apr. 1966, 5: 18, 27.

A procedure for testing leaks in HEPA filters to be used in clean rooms is given.

GUIDELINES FOR A BIOCLEAN SPACECRAFT ASSEMBLY AREA. Contamination Control, Aug. 1966, 5: 19, 23, 24, 26, 27.

"Salient points from a recent ITT RI survey of U. S. plants to locate areas suitable for conversion to clean rooms for assembling biologically sterile spacecraft." Author

Harris, George J., et al. TEST NEW ELECTRIC INCINERATOR DESIGN FOR STERILIZING LABORATORY AIR. Heating, Piping and Air Conditioning, Feb. 1964, 36: 94-95.

Air streams carrying infectious aerosols can be sterilized with the electric incinerator described. This new design is compact and provides ready access to heaters for maintenance. The results of performance tests on two sterilizers capable of handling 16 and 100 cfm are given.

Journals (continued)

Heuring, Harvey. COMBINING LAMINAR-FLOW WORK STATIONS WITH CLOSED LOOP CLEANING. Contamination Control, Jul. 1966, 5: 10-13, illus., diagrs.

"This paper describes a method of combining laminar-flow benches and other clean room equipment to provide maximum efficiency with a minimum amount of space. It covers the design of the equipment and facilities, the problem areas, and the results." Author

Heuring, Harvey. IBM MOBILE ROOM LENDS FLEXIBILITY TO APOLLO SATURN UNIT FABRICATION. Contamination Control, Apr. 1967, 6: 30-32,illus.

A portable clean room with a 12-foot high ceiling is used to provide clean conditions during final checkout at MSFC.

Hume, W. A. AN ANALYSIS OF CLEAN ROOM PRACTICES. Contamination Control, May 1966, 5: 10-13.

Surveys clean room classifications, design, interior appointments, environmental and clothing requirements, maintenance, certification, packaging and protection, and the selection and training of personnel.

Hume, William A. FACTORS IN VERIFICATION OF CLEANLINESS. Research/Development, Jul. 1965, 16: 22-26.

Two of the clean rooms of an aircraft corporation's laboratory are described. Air circulation, temperature, and humidity are rigidly controlled in these rooms, and all personnel wear special clothing according to the degree of cleanliness required.

Hume, William A. STANDARDIZING FOR ECONOMY IN CLEAN ROOM DESIGN AND CONSTRUCTION. Contamination Control, Apr. 1967, 6: 10-13, diagrs.

Design and construction guidelines for clean rooms are needed to help keep costs in line. Some suggestions are offered.

Journals (continued)

IN SEARCH OF A CLEAN ROOM. Heating, Piping and Air Conditioning. Jan. 1963, 35: 187-202.

Clean rooms have resulted from attempts to control fine particle contamination. These "white rooms" are indispensable in this age of missiles and miniaturization because of the enormous number of fine particles existing in the atmosphere, and the extremely small mating clearances and other physical limitations imposed upon a wide range of missile-age products. The pitfalls in designing clean rooms are carefully considered in this paper.

Israel, Milton W. CLEAN ROOM GARMENTS. Contamination Control, Dec. 1966, 5: 14-16.

Discusses fibers and fabrics available for use in clean rooms. The necessity for shoe covers, caps, and hoods is detailed. Includes some observations on bacteriological fallout from people.

Kenagy, J. A. APPLYING "DOWNFLOW" TO DUST-FUME CONTROL IN A PLASTIC FACTORY. Contamination Control, Jun. 1966, 5: 17-20, illus., diagrs.

A complete laminar downflow clean room, rather than a bench, helps solve the problem of dust and fume exhausting during potting and encapsulation procedures.

Kenagy, J. A. DESIGNING A "CLEAN ROOM" FOR PLASTICS PROCESSING. Modern Plastics, Nov. 1966, 44: 98, 99, 171, illus.

Describes one company's solution to the problem of dust and fume control in a facility handling epoxies, polyesters, and polyurethanes.

Kind, William O. DESIGN AND CONSTRUCTION OF A CLEAN ROOM FOR MICRO-ELECTRONICS FACILITY. Heating, Piping and Air Conditioning, Jun. 1966, 38: 103-108, illus., diagrs.

Describes the problems encountered while constructing a new clean room for the ITT Federal Laboratories, Nutley, N. J. The cleanliness criteria met were for Class 100,000 per Federal Standard 209.

Journals (continued)

Krokyn, William. AN ARCHITECT'S ADVICE ON HOW TO PLAN AND BUILD A CLEAN ROOM. Air Engineering, May 1965, 7: 20-27, illus., diagrs.

A very complete guide to the planning of a clean room is presented. Various types and arrangements of clean rooms are described. Floor plans are discussed.

Kutnewsky, Fremont. LAMINAR AIR FLOW. Compressed Air, Jan. 1965, 70: 13.

Laminar air flow means uniform movement of ultraclean air through a room or work station that literally "washes away" dust particles originating from equipment or personnel within the room. This principle was developed by a physicist employed by Sandia Corporation in New Mexico.

Kutnewsky, Fremont. LAMINAR DOWNFLOW SWEEPS BACTERIA FROM CLEAN ROOM, SANDIA EXPERIMENT HINTS. The Journal of the American Association for Contamination Control, Aug. 1965, 4: 8-11.

After six months of studies at Sandia Laboratory, it was found that eliminating 0.5 micron and larger airborne particulate contamination also eliminated airborne microbiological contamination -- bacteria and fungi.

LAMINAR AIR FLOW: A NEW BROOM THAT REALLY SWEEPS CLEAN. Engineering News-Record, 27 May 1965, 174: 62-64, illus.

RCA's vertical laminar-airflow clean rooms is described. It is estimated that the extra cost for constructing this type of clean room will be defrayed in two years by the reduction of scrap and the elimination of special facilities, janitorial tasks, and clothing for the workers. Each clean room is the core of a giant, three-level air-recirculating machine.

LAMINAR FLOW: STRONGER THAN DIRT. The Iron Age, Feb. 1965, 195: 71.

Clean rooms have become increasingly important in the manufacture of precision components. A new laminar flow room was built to permit manufacture of parts cleaner than ever before.

Journals (continued)

Lindeken, C. L. SELECTION, INSTALLATION AND MAINTENANCE OF WHITE ROOM FILTERS. Air Engineering, Feb. 1963, 5: 20-51.

The engineer will find information here on the criteria for evaluating, testing,and selecting filters for any white room air filtration requirements, along with tips on installation, uncrating, maintenance, and capacity loadings.

Little, James C. CLEAN-UP CHARACTERISTICS AND DOUBLE FILTRATION: TESTS CONDUCTED IN CLEAN ROOM SHOW HOW AIR FLOW RATES, TWIN FILTER BANKS INFLUENCE SYSTEM. Heating, Piping and Air Conditioning, Apr. 1966, 38: 111-115, illus., diagrs.

The report summarizes two studies conducted in AEC's Y-12 Plant in Oak Ridge, Tennessee, which indicate the effects of airflow rates and of double banks of superinterception filters on clean room operations.

Little, James C. FILTERS FOR CLEAN ROOM SERVICE. Heating, Piping and Air Conditioning, Sep. 1965, 37: 142-146.

Particle concentrations in six clean rooms with different equipment configurations have been given with test data and the author's suggestions for filter selection and installation.

Little, James C. MULTITESTING OF LAMINAR FLOW CLEAN ROOMS. Heating, Piping and Air Conditioning, Oct. 1965, 37: 133-136.

A clean room can be tested in many ways before being put into service. The various tests employed in clean rooms at Oak Ridge are summarized.

MACHINE TOOLS GAIN RELIABILITY BY ULTRA-CLEAN ASSEMBLY. Iron Age, 1 Jul. 1965, 196: 62-63, illus.

Precision machine tools are being assembled in clean room built to Government clean room standards. All metalworking machinery is isolated in separate rooms away from the main assembly area and downstream in the airflow system.

Journals (continued)

Magill, Paul L. AN AUTOMATED WAY TO COUNT FINE PARTICLES. Air Engineering, Oct. 1962, 2: 31-34.

Detailed data are included on the operation, application, and potential of automatic particle counters, and design criteria are given on monochromatic light scattering methods relating to development of the automatic counter.

Manning, Joachim E., and Phillips, Elbert E. LAMINAR DOWN-FLOW ASEPTIC AIR STATION CONTROLS BACTERIA AT SENSITIVE WORK AREA. Air Engineering, May 1966, 8: 15-16, illus., diagrs.

Describes how clean room procedures from the aerospace field were adapted to the drug industries' needs.

May, Alfred. GANTRY "WHITE ROOMS" AT CAPE KENNEDY. Contamination Control, Feb. 1967, 6: 9, 10, 13, 25, diagrs.

Distinguishes between "white rooms" and "clean rooms." Describes the problems in providing dirt and mildew controls and mentions the rooms which will be in use for the APOLLO and the MOL Programs.

Meckler, Milton. VALUE ENGINEER CONSIDERS CLEAN ROOM MATERIALS. Contamination Control, Mar. 1967, 6: 9-11, 30.

The criteria which guide a design engineer when selecting clean room interior materials are presented.

Meckler, P. E. INTERDISCIPLINARY DESIGN EVALUATION MODELS OF BIO-CLEAN FACILITIES ARE NEEDED FOR SPACECRAFT STERILIZATION. Air Engineering, Aug. 1966, 8: 32-37.

Turbulent eddies in conventionally designed "clean rooms" must be eliminated for a bioclean facility. Mathematical models for estimating microbial population are given.

Journals (continued)

Munkacsy, M. THE HUMAN FACTOR IN CLEAN ROOM OPERATION. Contamination Control, Jan. 1966, 5: 12-14, 18, illus.

Special aptitude tests are needed to select workers who are fitted both by skill and personality to work in a clean room. Careful orientation of workers followed by technical training will help keep the contamination down in clean rooms.

Murray, B. C., et al. PLANETARY CONTAMINATION II: SOVIET AND U. S. PRACTICES AND POLICIES. Science, 24 Mar. 1967, 153: 1505-1511, diagrs.

Clean room assembly practices seem to be the extent of sterilization used by the U. S. in the RANGER and SURVEYOR Programs. More stringent requirements are debated for Martian flybys and landings.

Olbur, Hugh M. SPACE AGE CHALLENGE: NEARLY CONSTANT ROOM TEMPERATURES. Heating, Piping and Air Conditioning, May 1964, 36: 137-141.

Precise measurement of space age components is being achieved in the Boeing Company's meteorology laboratory with an air-conditioning system that controls air temperature within plus or minus 0.1 degree.

Olivieri, Joe B. A CONSULTANT LOOKS AT CLEAN ROOM DESIGN. Air Conditioning, Heating and Refrigeration News, 29 May 1967, 3: 56-57.

Describes 14 of the configurations a clean room can assume and states that, in general, clean rooms are not maintained and operated properly.

OPEN-END CLEAN ROOM AT COLLINS RADIO FLEXIBLE, EXPANDABLE AND ECONOMICAL. Contamination Control, Jun. 1966, 5: 12, 14-15, illus.

Describes one of the largest existing clean rooms which can be expanded easily without having additional cost. The room is open ended using laminar-airflow control, in effect a laminar-flow tunnel.

Journals (continued)

Patnoe, C. L. CLEAN ROOM WALL BUILT OF BLOWER-FILTER MODULES. Plant Engineering, Aug. 1965, 19: 132-133, illus.

Describes the rapid construction of a horizontal laminar-flow clean room which can be expanded easily.

Paulhamus, J. A. A GUIDE TO THE REVISIONS IN FEDERAL STANDARD 209. Contamination Control, Oct. 1966, 5: 40-55.

Gives a guide to the portions of Federal Standard 209a changed or expanded. The text of the standard is also printed.

Portner, Dorothy M. MICROBIAL CONTROL IN ASSEMBLY AREAS NEEDED FOR SPACECRAFT STERILIZATION. Air Engineering, Oct. 1965, 7: 46-49.

Through the use of two separate clean room facilities, the number of viable aerobes and anaerobes that accumulate on a stainless steel surface in a clean room during one year was determined. The resistance of these microorganisms to heat shock (a technique that kills sensitive vegetative microorganisms but does not kill resistant organisms such as bacterial spores) was also determined. A comparative study was made of the level of aerobic aerial microbial contamination in a clean room by personnel (1) wearing clean room clothing, including masks, while sitting, (2) wearing clean room clothing while active, and (3) wearing street clothes while active.

Rice, Richard S. HOW THE SMALL BUSINESS CAN ACQUIRE CLEAN WORK SPACE. The Journal of the American Association for Contamination Control, Sep. 1965, 4: 9-23.

The small business man faces many problems of contamination control in manufacturing. Such items as special costs, tax factors, and types of clean rooms are discussed.

Rosebury, Fred. MINIMIZING CONTAMINATION FOR VACUUM. Research/Development, Jan. 1966, 17: 55-59.

"Techniques that avoid the pitfalls of contamination in cleanly handling vacuum devices - from electron tubes to walk-in chambers - result in uniformly better operation and in pinpointing trouble spots." Author

Journals (continued)

Salrin, Robert E. ONE YEAR'S EXPERIENCE IN A LAMINAR FLOW ROOM. Contamination Control, Oct. 1966, 5: 17-19, illus., diagrs.

A discussion of characteristics and problems of operating a 3,740 sq. ft., laminar-flow clean room. One unusual feature of the room is the elimination of the louvered return wall which reduced cost, eliminated balancing problems, and resulted in a 52-foot long air shower.

Schadewald, E. C. ENVIRONMENTALLY CONTROLLED ROOM FOR BEARING OVERHAUL FACILITY. Air Engineering, Oct. 1966, 8: 26, illus.

Gives the specifications for a horizontal laminar-flow clean room at U. S. Naval Air Station, San Diego, California.

Smith, Oliver F. HOW MECHANICAL SYSTEMS ENABLE MODERN ELECTRONICS MANUFACTURING. Heating, Piping and Air Conditioning, Sep. 1966, 38: 148-156, illus., diagrs.

Discusses design problems encountered when constructing buildings for modern electronics manufacturing. Clean rooms are economically designed to meet but not exceed the performance level. Localized portable environmental control systems are described.

Smith, O. F., Jr. ENVIRONMENTAL CONTROL FOR MANUFACTURING AREAS--WHAT KIND AND HOW MUCH? Heating, Piping and Air Conditioning, Nov. 1964, 36: 99-102.

The design of a clean room is a challenge to match environmental control to process requirements for maximum mutual economy, not an opportunity to erect a monument to engineering know-how.

Smith, O. F., Jr. HOW TO APPLY ENVIRONMENTAL CONTROL FOR MANUFACTURING AREAS. Heating, Piping and Air Conditioning, Dec. 1964, 36: 119-125.

Four case studies illustrate how environmental control problems encountered in manufacturing areas can be solved with maximum economy by applying sound engineering considerations. Illustrations of snow-white clean rooms are presented.

Journals (continued)

Steinber, Samuel B. CHECKING CONTAMINATION CONTROL INSTALLATIONS. Air Engineering, Jul. 1966, 8: 14-15.

States that a DOP test needs to be made of filter systems before particle counting can be properly evaluated. Significant leaks in the system must be eliminated.

Steinberg, Samuel B. LEAK TESTING CLEAN BENCHES WITH 'DOP'. Contamination Control, Apr. 1966, 5: 16-18, 27.

A standard testing procedure for leak testing clean work stations is proposed. Most defects are simple to repair.

Stockham, J. D. Roberts, and Zastera, R. MISSIONS TO MARS SPUR SURVEY OF BIOCLEAN ROOMS. Heating, Piping and Air Conditioning, Oct. 1966, 38: 104-109, diagr.

Reports on a survey of a cross section of clean assembly areas to determine their suitability for conversion to bioclean rooms for the assembly, checkout, and decontamination of small spacecraft. Laminar-downflow clean rooms will probably be most useful. Decontamination areas for spacecraft must also be provided.

Stockman, J. D., et al. RESULTS OF BIOCLEAN ROOM SURVEY. Heating, Piping and Air Conditioning, May 1967, 39: 115-117.

Describes the conduct and results of a survey to determine suitability of conversion of clean rooms to bioclean rooms. Points out areas requiring further study and definition.

SUPERCLEAN. Electronics, 20 Feb. 1967, 40: 58, 60, 61, illus.

Describes clean room facilities and techniques used by various semiconductor manufacturers.

SUPERCLEAN FOR SUPERCOLD. Compressed Air Magazine, May 1966, 71: 45.

Describes a prefabricated clean room built by Baker Co. to clean, assemble, and test pumps, filters, and other components for cryogenic applications.

Journals (continued)

SUPER-CLEAN WHITE ROOM. Research/Development, Apr. 1965, 16: 36-37.

A white room constructed by General Electric Company in Lynn, Massachusetts provides super-clean conditions for the assembly of gyroscopes, accelerometers, and other precision units for aerospace applications.

Taylor, Leonard M., et al. ADVANCES IN CONTROLLED ENVIRONMENT AREAS. Electronic Industries, Dec. 1964, 23: 63-65, illus., diagrs.

Discusses the impact of Federal Standard 209 on the electronics field. Includes a table of various methods of achieving different clean room classes.

TECHNICAL PRODUCT ANALYSIS: CLEAN ROOMS. CLEAN ROOM ACTIVITIES EXPAND: FROM AEROSPACE TO THE HOSPITAL. Space Age News, May 1967, 10: 14, 16, 18, 20-24.

Discusses clean room applications and markets. Includes corporate profiles of industries prominent in the clean room field.

Truslow, J. D. CONTROL OF ENVIRONMENT FOR A MICROELECTRONIC FURNACE ROOM FACILITY. Air Engineering, Dec. 1966, 8: 20-23, diagrs.

Describes a furnace room for microelectronics assembly, which adheres to Federal Standard 209 classification of 100,000 particles 0.5 micron or larger per cubic foot of air.

Truslow, J. D. CONTROLLING ENVIRONMENT IN GAS BEARING ROOMS OF GYROFACILITY. Heating, Piping and Air Conditioning, Jun. 1967, 39: 103-107, illus., diagrs.

Describes a clean room used as part of a facility for gas bearing rooms for gyroscope production.

Journals (continued)

U-HEPA FILTERS...FURTHER COMMENTS ON NEED AND AVAILABILITY. Air Engineering, Sep. 1966, 8: 16-18.

Filter manufacturers answer an article by Philip Austin on the need for U-HEPA filters.

Wathen, Paul, and Lough, Wendell. CLEAN ROOMS DON'T JUST HAPPEN. Plant Engineering, Dec. 1963, 17: 106-109.

Important factors must be considered before a clean room can be designed. These factors are cleanliness, temperature levels, humidity fluctuations, and optimizing lighting levels.

WESTERN GEAR ROOM HAS CLEAN ROOM AND GRAY AREA. Contamination Control, Mar. 1967, 6: 27.

Describes a unified facility concept to provide maximum control of product and obtain a clean environment.

Whitfield, W. J. MONITORING LAMINAR DOWNFLOW ROOMS. Contamination Control, May 1966, 5: 28, 29, 34, diagrs.

Uses of station and performance monitoring (with typical procedures for a monitoring program) are outlined, and some specific steps are recommended.

Documents

Air Force Logistics Command, Olmsted AFB, Pennsylvania, Industrial Engineering Division. LAMINAR AIR-FLOW CONCEPT FOR CLEAN ROOM CONSTRUCTION, 31 Jul. 1963, 15 p.

Facts concerning the laminar flow principle are presented in this study. Such laminar flow principles as those applied to clean room design, and the adaptability of laminar-flow rooms to production work are explained.

Arnold, V. E., et al. PRELIMINARY REPORT ON MICRO-BIOLOGICAL STUDIES IN A LAMINAR DOWN-FLOW CLEAN ROOM, Sandia Corp., Albuquerque, New Mexico. Jan. 1965, 27 p. (SC-RR-65-47; N65-19646).

Results of experiments reported indicate that the laminar-downflow clean room - using filtration and airflow control alone - can control airborne bacteria and fungi as successfully as it can airborne dust and droplets.

Beakley, J. W., et al. DEPOSITION OF NUTRIENTS TO SURFACES BY RODAC PLATES (PART II OF MICROBIOLOGICAL STUDIES RELATING TO CLEAN ENVIRONMENTS). Sandia Corp., Albuquerque, New Mexico, Sep. 1966, 16 p., illus. (NASA CR-78766; SC-RR-66-386; N66-39373).

A study of the monitoring of surfaces within a clean room using agar impressions with a Rodac plate.

Beakley, J. W., et al. EVALUATION OF THE EFFICIENCY OF A CLASS 100 LAMINAR-FLOW CLEAN ROOM FOR VIABLE CONTAMINATION CLEANUP, PART I: MICROBIOLOGICAL STUDIES RELATING TO CLEAN ENVIRONMENTS. Sandia Corp., Albuquerque, New Mexico, 1966, 10 p. (NASA CR-78342; SC-RR-66-385; N66-37585).

"A laminar-flow wall-to-floor clean room was challenged with Bacillus subtilis spores and then tested for efficiency of cleanup using both electronic and viable particle detection systems. The results confirmed the extreme efficiency of laminar-flow systems in reducing airborne viable particles to an absolute minimum." Author

Documents (continued)

Bloomquist, R. L. GUIDELINES AND PROCEDURES FOR OPERATION OF NASA UNMANNED SPACECRAFT ASSEMBLY AND CHECKOUT CLEAN ROOM FACILITIES. Rev. A., National Aeronautics and Space Administration, Kennedy Space Center, Florida, Oct. 1965, 66 p. illus., diagrs. (KSC LSOD 53-201 Rev. A, Prel.).

Describes Kennedy Space Center clean room facilities and includes procedures for monitoring, maintenance, and personnel training.

Butterfield, J. MEASUREMENT AND IDENTIFICATION OF DUST PARTICLES. Boeing Co., Seattle, Wash., Jul. 1962, 20 p. (MDR-2-14983, IDEP 347.60.00.00-C6-02).

"It is recommended that the ranking of cellulose container materials herein be used as a guide for evaluation of paper products intended for use in clean rooms." Author

Drummond, D., and Magistrale, V. JPL SPACECRAFT STERILIZATION TECHNOLOGY PROGRAM: A STATUS REPORT. Jet Propulsion Laboratory, Pasadena, Calif., 31 Dec. 1965, 102 p., illus., diagrs. (JPL-TR-32-853).

This document presents the technical status of JPL's spacecraft sterilization program, including clean room design and development.

Favero, Martin S., et al. COMPARATIVE LEVELS AND TYPES OF MICROBIAL CONTAMINATION DETECTED IN INDUSTRIAL CLEAN ROOMS, Report No. 9. Public Health Service, Technology Branch, Phoenix, Arizona, 9 Dec. 1965, 46 p. (NASA CR-69216; N66-15001).

"This study was conducted to determine quantitatively and qualitatively the predominant types of microbial contamination in conventional and laminar-flow clean rooms. Results showed that as the environment and personnel of a clean room were controlled with respect to reducing particulate contamination, microbial contaminants were reduced." STAR

Documents (continued)

Fox, Gertrude W. DESIGN OF CLEAN ROOMS: A CLASSIFIED LIST OF SELECTED REFERENCES 1955-1964. U. S. Department of Health, Education, and Welfare, Bethesda, Maryland, Public Health Service. 1964, 11 p. (HEW Pub. Health Bib. Series No. 54).

Emphasis is placed on biomedical applications. References are limited to those written in the English language. Entries are alphabetical under broad subject headings. Some brief annotations and an author index are included.

Israel Program for Scientific Translations, Ltd., Jerusalem. STAUB, VOLUME 26, NO. 8. Aug. 1966, 47 p. (Translated into English from German.) Published for NSF and Dept. of Health, Education, and Welfare. (N67-23440).

"Hygiene effects and control of dusts, fogs, gases, vapors, and radioactive particles are discussed." STAR

Kapell, G. F., et al. EXPERIMENTAL ASSEMBLY AND STERILIZATION LABORATORY (EASL) OPERATIONS: PHASE I. Jet Propulsion Laboratory, Pasadena, Calif., 15 Apr. 1966, 21 p., illus., diagrs. (JPL-TR-32-941).

Describes the clean room used in the spacecraft sterilization operations at JPL.

Lewis, Theodore W. EVALUATION OF AN AUTOMATIC AEROSOL PARTICLE COUNTER FOR MEASURING THE AIRBORNE CONTAMINATION LEVEL IN A CONTROLLED ENVIRONMENT. National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Alabama, 24 Mar. 1966, 39 p. (NASA TM X-53416; N66-29075).

"The automatic aerosol particle counter and the microscopic particle counts were in satisfactory agreement. However, the automatic counter is more efficient in counting particles at 0.6 micron or 0.75 micron as compared to the microscopist, who is restricted to counting particles 5 microns or larger. A method of correlating the sizes and quantities of particulate contamination present at any time is submitted for consideration. By using the particle size distribution curve, based on Stokes' Law, the number of particles for each different size may be estimated. Acceptance of this method will make it possible to use the automatic counters in a continuous monitoring program. This will provide a prompt recording of the contamination level in the environment monitored." Author

Documents (continued)

Little, J. C. Y-12 CLEAN ROOM FACILITIES. Union Carbide Nuclear Co., Y-12 Plant, Oak Ridge, Tenn., 14 Mar. 1966, 31 p. (Y-EA-49; N66-34748).

"Clean room facilities at the Y-12 plant are described, along with testing methods used to determine contamination. The two methods primarily used to control contamination are the absolute filter and the laminar-flow concept of air distribution. Environmental conditions at Y-12 are also discussed." NSA

Michaelsen, G. S. THE BACTERIOLOGY OF "CLEAN ROOMS." Minnesota University, School of Public Health, Minneapolis, Minnesota, Progress Report, 1 Oct. 1964 through Mar. 1965, 13 p. (NASA CR-63470; N65-27296).

Routine bacteriological ambient air, bench top surface, and stainless steel strip contamination sampling was carried out on eight occasions in each of four rooms representing different ranges of environmental control and personnel practices in regard to cleanliness.

National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md. STERILIZATION--A SELECTED BIBLIOGRAPHY FROM THE LITERATURE RETRIEVAL SYSTEM, SPACE BIOLOGY BRANCH. Mar. 1966, 25 p. (NASA TM X-55457; X-450-66-53; N66-24690).

An annotated bibliography with topical headings is presented. These headings include: (1) clean rooms; (2) decontamination; (3) sterilization methods, i. e., air filtering, chemicals, and heat; (4) methods; (5) spacecraft sterilization; and (6) survival, i.e., viability of microorganisms.

National Aeronautics and Space Administration, Kennedy Space Center, Florida. CLEAN ROOMS, A STUDY BY FACILITIES ENGINEERING AND CONSTRUCTION DIVISION. 1 Dec. 1964, 23 p., illus., diagrs.

Discusses KSC clean rooms and applicable standards. Includes a list of existing and proposed clean rooms for NASA KSC areas.

National Aeronautics and Space Administration, Office of Manned Space Flight, Washington, D. C. HANDBOOK FOR CONTAMINATION CONTROL ON THE APOLLO PROGRAM. Aug. 1966, 208 p. (NHB 5300.3).

Contains general information, technical and operating data, and reference material on contamination control, including clean room uses and procedures.

Documents (continued)

Opfell, John B., et al. STERILIZATION HANDBOOK. Dynamic Science Corporation, South Pasadena, Calif., 26 Aug. 1964. 176 p., illus., diagrs. (NASA CR 62837, Dynamic Science Corp. - SN-37 (FR); N65-24296).

Describes techniques for internal sterilization and aseptic assembly, and their application to clean room facilities. Also describes terminal sterilization and emergency field repair of sterilized spacecraft components, subsystems, and assemblies.

Portner, D. M., et al. MICROBIAL CONTAMINATION IN A CLEAN ROOM WHEN OCCUPIED BY OPERATING PERSONNEL. Army Biological Laboratories, Fort Detrick, Maryland, Physical Defense Division. Aug. 1964, 12 p. (NASA CR-58369; X64-16097).

As part of an overall study of spacecraft sterilization, a clean room was investigated to determine microbial contamination resulting from the presence of personnel. The results reported compare the level of microbial contamination by personnel (1) wearing clean room clothing (including masks) while sitting, (2) wearing clean room clothing while active, and (3) wearing street clothes while active.

Portner, D. M., et al. MICROBIAL CONTAMINATION IN CLEAN ROOMS. Army Biological Laboratories, Fort Detrick, Maryland, Physical Defense Division, Mar. 1965, 17 p. (AD 459 387; X65-15789).

A study to determine the level of microbial contamination in an industrial clean room was undertaken as part of the spacecraft sterilization investigations.

Portner, D. M. THE LEVEL OF MICROBIAL CONTAMINATION IN A CLEAN ROOM DURING A ONE YEAR PERIOD. Army Biological Laboratories, Fort Detrick, Maryland, Physical Defense Division, Dec. 1964, 20 p. (NASA CR-60184; N65-15148).

Reports a study to find the level of microbial contamination in a clean room in order to decide whether it is advantageous from a minimal microbial contamination standpoint to assemble a spacecraft in such an area.

Documents (continued)

Portner, Dorothy M. THE LEVEL OF MICROBIAL CONTAMINATION IN A CLEAN ROOM DURING AN ELEVEN WEEK TEST PERIOD. Army Chemical Corps , Fort Detrick, Maryland, Physical Defense Division. Feb. 1964, 18 p. (NASA CR-53127; X64-12719).

An investigation was made to determine the level of microbial contamination in a clean room designed to enumerate only the viable aerobic and anaerobic microorganisms present. An essential part of the study was to determine the number of viable aerobes and anaerobes that accumulate on a stainless-steel surface over an extended period.

Powers, Edmund M. MICROBIAL PROFILE OF LAMINAR-FLOW CLEAN ROOMS. National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md., Sep. 1965, 46 p. (NASA TM X-55320; X-600-65-308; N66-11215).

"The presence of personnel increased counts in the crossflow but not in the down-flow rooms. Results indicate that the use of sterile clothing including gloves and proper handling procedures together with a laminar flow could reduce microbial contamination considerably." STAR

Public Health Service. RESEARCH ON MICROBIOLOGICAL STERILIZATION PROBLEMS. QUARTERLY REPORT, Oct.-Dec. 1966, Public Health Service, Phoenix, Ariz., 18 Jan. 1967, 23 p. (NASA-CR-81775; Rept. - 16; N67-18139).

"Reports on monitoring of microbial contamination at Cape Kennedy in hangars, in the SURVEYOR sterilization and assembly laboratory, the fuel loading room, in the lunar orbiter camera room and in the BIOSATELLITE clean room. Results are presented in tabular form." STAR

Ralph M. Parsons Company. LC-39 VERTICAL ASSEMBLY BUILDING SERVICE AND MAINTENANCE MANUAL CLEAN ROOMS. National Aeronautics and Space Administration, Technical Information Office, 1 Aug. 1966, various paging, illus., diagrs. (Ralph M. Parsons TM 4-133-39).

Contains drawings and specifications for the clean room in the VAB.

Documents (continued)

Riley, Charles. THE ARMY'S NEW INERTIAL GUIDANCE AND CONTROL FACILITY. Army Missile Command, Huntsville, Alabama, Inertial Guidance and Control Laboratory. Mar. 1965, 58 p. (AD 464 175; N65-26235).

Identifies and describes the special features and equipment provided in the Army's new Inertial Guidance and Control Laboratory located at Redstone Arsenal, Alabama.

Ruschmeyer, O. R., and Vesley, D. THE BACTERIOLOGY OF "CLEAN ROOMS". FINAL REPORT. Minnesota Univ., School of Public Health, Minneapolis, Minn., Jul. 1966, 89 p. (NASA CR-79114; N66-39919).

"Presented are results of comparative studies of microbial levels in the environments of four industrial clean rooms which were made to determine the difference in contamination levels related to the specific controls in each room; an evaluation of specific factors thought to be important in minimizing the level of contaminants on space hardware; and preliminary comparative data on microbial contamination levels in a laminar-flow room and conventional clean rooms." STAR

Sandia Corp. SCOPE OF WORK FOR SCIENTIFIC AND TECHNICAL ASSISTANCE FOR THE PLANETARY QUARANTINE MISSION. First Quarterly Report, Period Ending Jun. 30, 1966. Sandia Corp., Planetary Quarantine Dept., Albuquerque, New Mexico. Jul. 1966, 17 p. (NASA CR-76987; N66-32760).

"Systems support activities discussed are a design for a high-rate aerosol particle sampler, study of fine particle behavior on surfaces and assistance in the clean room design and requirements." STAR

Technisch Documentatie en Informatie Centrum voor de Krijgsmacht, The Hague (Netherlands). SURVEY OF LITERATURE ON BUILDINGS FOR THE ARMED SERVICES (LITERATUUROVERZICHT KRIJGSBOUWKUNDE) 4 Mar. 1966, 23 p. (N66-21174).

"Contains abstracts and bibliographic notes on general applied mechanics, cement, health techniques and clean rooms, civilian construction, atomic-biologic-chemical warfare, and technical news." STAR

Documents (continued)

Terry, John E. STERILIZATION OF UNMANNED PLANETARY SPACECRAFT. Redstone Scientific Information Center, Redstone Arsenal, Alabama, 15 Nov. 1965, 26 p., diagrs. (RSIC-490).

A brief summary of recent studies on spacecraft sterilizations is presented, various sterilizing agents and methods are listed, as are clean room requirements, personnel requirements, etc.

Wright, Donald E. BIBLIOGRAPHY ON CLEAN ROOMS. George Washington University, Biological Sciences Communication Project, Washington, D. C., Nov. 1966, 55 p.

This bibliography covers the years 1939-1966, and includes books, documents, and magazine articles on clean rooms. Also includes a "permuted" index and author index.

Wu, M. A DUSTLESS FACTORY, A SPECIAL ENVIRONMENTAL REQUIREMENT IN THE MANUFACTURE OF PRECISION GYROSCOPES. Hang K'Ung Chih Shih (Aeronautical Knowledge), vol 2, No. 7, 1965, pp. 8-10. Prepared by: Translation Division Foreign Technology Division WP-AFB, Ohio. 9 p. (FTD-HT-66-412/1 + 2 + 3 + 4, AD650 745).

Describes a Chinese gyroscope-assembling factory in which particulate contamination has been reduced to an 0.3-micron concentration. The entire factory is considered a clean area, and even the surroundings are to be kept under maximum dust control conditions.

Symposia

American Association for Contamination Control. AUSTIN CONTAMINATION INDEX, by Philip R. Austin. Fourth Annual Technical Meeting and Exhibit, May 1965, 4 p.

In designing a clean room, the contamination load must be predicted. This Index allows contamination loads for clean rooms to be predicted.

American Association for Contamination Control. CLEANING THE "ZIP" GUN FOR ASTRONAUT WHITE'S WALK IN SPACE, by C. D. Reno. Fifth Annual Technical Meeting and Exhibit, Mar. 29 - Apr. 1, 1966, 3 p.

"Description of the cleaning techniques used for the 'zip gun,' or hand-held maneuvering unit (HHMU) and environmental life-support system, or ventilation control module (VCM) used during the walk in space by astronaut White on GEMINI flight GT-4. Brief descriptions of the HHMU and VCM are included. Cleaning requirements were to free all parts of contaminants that might constitute a chemically reactive hazard in an oxygen system and to remove all solid contaminants which might cause equipment malfunction. These were achieved by using solvent flushing with three different solvents, followed by filtered nitrogen gas drying, inspection, and packaging in double bags. Allowable contamination levels are specified, and some minor cleaning problems encountered are described." W.A.E.

American Association for Contamination Control. CLEAN ROOM DESIGN CRITERIA AND THEIR RELATION TO COST, by Richard S. Rice. Second Annual Convention, April-May 1963, 10 p., AACC Pub. 63-19.

Analysis is made of the effect of design criteria decisions on construction costs for facilities concerned with aerospace technology.

American Association for Contamination Control. DESIGN AND CONSTRUCTION OF A 20,000 SQUARE FOOT DOWN FLOW CLEAN ROOM, by F. C. Weisbach. Fourth Annual Technical Meeting and Exhibit, May 1965, 11 p.

The problems encountered by RCA in designing clean rooms for their 157,000 square foot plant at Lancaster, Pennsylvania, are described. This facility represents one of the most complex engineering and manufacturing buildings within the electronics industry.

Symposia (continued)

American Association for Contamination Control. THE DESIGN OF AN R&D CLEAN ROOM COMPLEX FOR GUIDANCE AND CONTROL SYSTEMS, by Will Gibson. Fourth Annual Technical Meeting and Exhibit, May 1965, 10 p.

Layout, equipment, operation, and cost of the clean room built by the Army at its Inertial Guidance and Control Laboratory, Huntsville, Alabama, are discussed.

American Association for Contamination Control. EXTENDED PARAMETERS FOR CLEAN ROOM DESIGN AND CONSTRUCTION, by J. J. Mooney. Second Annual Convention, April-May 1963, 3 p. AACC Pub. 63-2.

Discusses additional parameters vital to the resultant design and feasibility of employing clean rooms in the manufacture and development of products.

American Association for Contamination Control. HOW CLEAN IS THE ROOM?, by J. Mason Pilcher. Second Annual Convention, April-May 1963, 20 p. AACC Pub. 63-4.

The problem of airborne contaminant monitoring in clean rooms is discussed. Recommendations are made for proper air-sampling procedures and clean room monitoring techniques.

American Association for Contamination Control. MICROBIAL CONTAMINATION IN CONVENTIONAL AND LAMINAR FLOW CLEAN ROOMS, by Martin S. Favero. Fifth Annual Technical Meeting and Exhibit, Mar. 29-Apr.1, 1966, 11 p. diagrs. (NASA CR 81751, N67-18081).

The objective of this study was to determine quantitatively and qualitatively the types of microbial contamination found in conventional and laminar-flow clean rooms. Floor plans of the clean room areas studied are included, and tables showing the levels of microbial contamination accumulation for each room are given.

Symposia (continued)

American Association for Contamination Control. MICROBIOLOGICAL CONTAMINATION IN CLEAN ROOMS AND BIOCLEAN ROOMS, by Karl Kereluk. Fourth Annual Technical Meeting and Exhibit, May 1965, 10 p.

Boeing Company has conducted studies during the past year to acquire information on the microbiological contamination levels of clean room facilities within the company. These studies and the results obtained are reported.

American Association for Contamination Control. PRINCIPLES OF ULTRACLEANING FLUSH CLEANING SYSTEMS, by Walter W. Kenyon. Second Annual Convention, April-May 1963, 10 p. AACC Pub. 63-28.

The author points out that flush cleaning is usually the final and most critical operation in assuring cleanliness of fluid handling or fluid containing systems.

American Association for Contamination Control. SIGNIFICANT PARAMETERS OF CLEAN ROOM DESIGN, by Ernest E. Choat. Fourth Annual Technical Meeting and Exhibit, May 1965, 11 p.

"High-Purity Laboratory," erected at the Atomic Energy Commission's Oak Ridge Y-12 Plant is described. Design parameters as they apply to vertical laminar flow rooms are discussed. Concept and design, construction, and performance data have been taken into consideration.

American Association for Contamination Control. USE OF DUST CONTROLLED HOODS IN WHITE ROOMS, by Marvin A. Pratt. Second Annual Convention, April-May 1963, 6 p. AACC Pub. 63-21.

This paper deals mainly with shrouded workplaces, called Sterilshields, where controlled environment is provided for articles from about one cubic foot of volume down to the subminiature. It does recognize that room-size environmental control may be the only pattern for protection for large objects, or large assemblies of smaller components.

Symposia (continued)

American Association for Contamination Control. VERIFICATION OF AEROSPACE FACILITIES LEVELS TO MEET MILITARY SPECIFICATIONS, by Kenneth Halliday. Fourth Annual Technical Meeting and Exhibit, May 1965, 10 p.

Outlines steps required before a clean room can be qualified to meet military specifications.

American Society for Testing and Materials. SYMPOSIUM ON CLEANING AND MATERIALS PROCESSING FOR ELECTRONICS AND SPACE APARATUS. Fourth Pacific Area Meeting, Oct. 1-3, 1962 (ASTM Special Technical Publication No. 342). American Society for Testing and Materials, Philadelphia, 1963, 266 p., illus., diagrs. (Ref. TK7870/5989).

The first section contains papers on clean rooms and clean areas particularly the monitoring and detection of contaminants in these areas.

American Society of Tool and Manufacturing Engineers. THE DESIGN OF A CLEAN ROOM UNDER FEDERAL STANDARD #209, by William B. Meyer. 1965, 11 p. ASTME Paper No. 676.

"Definition, general description and design of clean room under Federal Standard No. 209 required for manufacturing minute precision parts with ultimate in clearance and tolerance . . ." Engineering Index

American Society of Tool and Manufacturing Engineers. MANUFACTURING UNDER CLEAN ROOM CONDITIONS, by Kenneth C. Halliday. 1965, 22 p., illus., diagrs. ASTME Paper No. 678 .

Discusses the operational characteristics of the clean room facilities at Bendix Corporation's Eclipse-Pioneer Division. Also discusses dust-particle monitoring and dust-particle surveying in clean room environments.

Institute of Environmental Sciences. A NEW APPROACH TO CLEAN ROOM DESIGN. Proceedings of Institute of Environmental Sciences, 1962 (TA1/I59).

Contains an article by Willis J. Whitfield on how Sandia Corporation, Advanced Manufacturing Development Division, has pinpointed three major problems in trying to improve clean rooms.

Symposia (continued)

Institute of Environmental Sciences. 1962 ANNUAL TECHNICAL MEETING PROCEEDINGS. Apr. 11-13, 1962. Institute of Environmental Sciences, Mt. Prospect, Illinois, 606 p., 1962. (Ref. TA1/I59).

Includes an article entitled "A New Approach to Clean Room Design."

Institute of Environmental Sciences. 1966 ANNUAL TECHNICAL MEETING PROCEEDINGS. Apr. 13-15, 1966. Institute of Environmental Sciences, Mt. Prospect, Illinois, 648 p., 1966. (Ref. TA1/I59).

Includes an article entitled "Microbiological Contamination in Clean Rooms."

Institute of Environmental Sciences. 1967 ANNUAL TECHNICAL MEETING PROCEEDINGS. Apr. 10-12, 1967. Institute of Environmental Sciences, Mt. Prospect, Illinois, Volume 1, 343 p., 1967. (Ref. TA1/I59).

Contains an article on an ultraclean vacuum environment.

National Academy of Sciences. THE ROLE OF HUMAN FACTORS IN WHITE ROOM MANUFACTURING RELIABILITY, by Edward Gavurin. Seventh Mil-Ind Missile and Space Reliability Symposium, Jun. 1962, 7 p. (N63-172761).

The effect of selection, training, motivation and morale, and the special requirements for glove-handed operations upon the reliability of white room workers is discussed.

National Aeronautics and Space Administration. SPACECRAFT STERILIZATION TECHNOLOGY 1966. Conf. held Pasedena, Calif., Nov. 16-18, 1965. 601 p. (NASA SP 108; N67-1476).

Contains conference papers on NASA sterilization requirements, microbiological control, and monitoring and sterilization techniques. The role of clean rooms in spacecraft sterilization is explored.

Parenteral Drug Association, Inc. MICROBIOLOGICAL STUDIES OF LAMINAR FLOW ROOMS, by W. J. Whitfield. Annual Convention, Nov. 2, 1966, 18 p. (SC-DC-66-2277; Conf-661106-1; N67-21607).

The laminar flow concept, and how it works, is briefly described. A review of microbiological studies conducted in laminar-flow rooms is included.

Symposia (continued)

Sandia Corporation, Albuquerque, New Mexico. CONFERENCE ON CLEAN ROOM SPECIFICATIONS HELD AT SANDIA LABORATORY, ALBUQUERQUE, NEW MEXICO, APRIL 9-10, 1963, by B. A. Bice, et al., May 1963, 103 p. (SCR-652; N63-16287).

The objectives of this conference were to develop a Federal Performance Standard for the construction, operation, and monitoring of clean room facilities.

Sandia Corporation, Albuquerque, New Mexico, Advanced Manufacturing Development Division. DUST MONITORING IN CLEAN ROOMS. Aug. 1961, 49 p. Working Paper, SCTM 131-61(25).

Reports the overall clean room problem with particular emphasis on developing an adequate system for the detection, measurement, and control of airborne dust in clean rooms. These papers were presented at the Clean Room Monitoring Seminar held on March 28 and March 31, 1961.

SURFACE CONTAMINATION. Fish, B. R., Editor. Proceedings of a Symposium held at Gatlinburg, Tennessee, June 1964. Pergamon Press, Oxford, 1967, 415 p., illus. (Ref. TH7692/I61).

Contains papers on clean room technology and training programs.

Books

Agnew, Boyd. LAMINAR/FLOW CLEAN ROOM HANDBOOK, Second Edition, Agnew-Higgins Publishing Company, Garden Grove, California, 1965, 77 p. (TH7694/A273).

This handbook explains how laminar flow clean air handling equipment works and how to apply it to the various needs for a clean working environment. Chapters deal with design criteria and performance of blower-filter modules for laminar flow clean rooms, typical room and booth layouts using blower-filter modules, typical uses of laminar flow work stations, and questions and answers about laminar flow clean rooms.

Austin, Philip R., and Timmerman, Stewart. DESIGN AND OPERATION OF CLEAN ROOMS. Business News Publishing Company, Detroit, Michigan, 1965, 427 p. (TH7694/A937).

Theoretical relationships governing airborne particulate matter, substantiated by experimental size-distribution data, are presented in the first section of this book, along with discussions and analyses of filtration, product requirements, and design of conventional and second-generation clean rooms. The second section discusses the operation of clean rooms and clean work stations, along with the particular subjects of monitoring, garmenting, cleaning of parts, and clean room specifications.

1967 CONTAMINATION CONTROL DIRECTORY. Blackwent Publishing Co., Los Angeles, Calif., 1967, 120 p., illus. (Ref. TH7694/C 759).

"A comprehensive directory to sources of equipment, supplies and services used in the field of contamination control within closed systems." Author

Dwyer, James L. CONTAMINATION ANALYSIS AND CONTROL. Reinhold, New York, 1966, 343 p. (Ref. TH7692/D993).

All areas of contamination control are examined, including clean room techniques and operation.

Morrow, L. C., Editor. MAINTENANCE ENGINEERING HANDBOOK. 2d ed., McGraw-Hill Book Co., New York, 1966, various paging, diagrs. (TS155/M883/1966).

A short chapter, "Clean Room Construction and Maintenance," includes rules for workers.

Books (continued)

Nowitzky, Albin M. SPACECRAFT STERILIZATION, TECHNIQUES AND EQUIPMENT. Johnson Publishing Company, Boulder, Colorado, 1965, 356 p., illus., diagrs. (Ref. TL782/N948).

The role of clean rooms in spacecraft sterilization is discussed in the chapter "Sterilization Aerospace Ground Equipment (SAGE) and Facilities."

Specifications and Standards

Air Force. STANDARDS AND GUIDELINES FOR THE DESIGN AND OPERATION OF CLEAN ROOMS AND CLEAN WORK STATIONS, 31 Aug. 1965, 57 p. (T. O. 00-25-203).

This Technical Order lists guidelines for achieving environmental control operating standards to be used by Air Force activities as the minimum criteria for the overhaul of items requiring environmental control.

American Society for Testing and Materials, Philadelphia, Pennsylvania. TENTATIVE METHOD FOR SAMPLING AIRBORNE PARTICULATE CONTAMINATION IN CLEAN ROOMS FOR HANDLING AEROSPACE FLUIDS. 1965, 3 p. (ASTM D 2407-65T).

This method covers a procedure for sampling airborne particulate matter larger than 5.0 microns. It is designated to be used in clean rooms where aerospace fluids are handled.

American Society for Testing and Materials, Philadelphia, Pennsylvania. TENTATIVE METHOD FOR SIZING AND COUNTING AIRBORNE PARTICULATE CONTAMINATION IN CLEAN ROOMS AND OTHER DUST CONTROLLED AREAS DESIGNED FOR ELECTRONIC AND SIMILAR APPLICATIONS. Vol. 8, 1965, 11 p. (ASTM F 25-63T).

Presents a procedure for counting and sizing airborne particulate matter 5.0 microns and larger. The sampling areas are specifically those with contamination levels typical of clean rooms.

American Society for Testing and Materials, Philadelphia, Pennsylvania. TENTATIVE METHOD OF TEST FOR CONTINUOUS COUNTING AND SIZING OF AIRBORNE PARTICLES IN DUST-CONTROLLED AREAS BY THE LIGHT-SCATTERING PRINCIPLE (FOR ELECTRONIC AND SIMILAR APPLICATIONS). Vol. 8. 1965, 11 p., diagrs. (ASTM F 50-65T).

A method is presented for the determination of the particle concentration and size distribution of airborne particles in dust-controlled areas. Particle concentrations not exceeding 30,000 particles/liter (1,000,000 particles/pt) for particles 0.5 to 5.0 microns are covered.

Specifications and Standards (continued)

Army Missle Command, Huntsville, Alabama. DEGREE OF CLEANLINESS AND CLEAN-ROOM REQUIREMENTS. Dec. 1962, 10 p. (MIL-STD-1246 (MI).).

Provides uniform criteria for minimum cleanliness and clean room requirements and serves as a guide in the selection of suitable cleaning agents and procedures for items of Military Material.

Federal Supply Service, Washington, D. C. CLEAN ROOM AND WORK STATION REQUIREMENTS, CONTROLLED ENVIRONMENT. 10 Aug. 1966, 21 p., illus., diagrs. (Federal Standard No. 209a).

Revises Federal Standard 209 dated December 16, 1963. Provides standardized definitions and levels of environmental control for clean rooms.

National Aeronautics and Space Administration, George C. Marshall, Space Flight Center, Huntsville, Alabama. DESIGN AND OPERATIONAL CRITERIA OF CONTROLLED ENVIRONMENT AREAS (COVER SHEET FOR FED. -STD-209A), STANDARD. Apr. 1967, 2 p. (MSFC-STD-246A).

Lists changes to Fed. -STD-209A which make it compatible with NASA/MSFC requirements.

National Aeronautics and Space Administration, Manned Spacecraft Center, Houston, Texas. APOLLO SPACECRAFT, CLEANLINESS, SPECIFICATION FOR. Sep. 1966, 17 p. (MSC-SPEC-C-5A).

"This specification establishes the minimum cleanliness requirements for assembled spacecraft Command Module (CM), Command/Service Module (CSM), and/or Lunar Module (LM) in manufacturers' final assembly and checkout area, environmental test chambers, and at launch site test and checkout areas. It also includes requirements for maintaining cleanliness standards during shipment and while spacecraft components are being removed or replaced." Author

Specifications and Standards (continued)

National Aeronautics and Space Administration, Manned Spacecraft Center, Houston, Texas. CLEAN ROOMS AND WORK STATIONS. 7 Oct. 1966, 19 p. (MSC-STD-C-4).

This standard describes classes of environmental air control within clean rooms and clean work stations. It also prescribes air cleanliness classes and certain other environmental air conditions required for achieving and maintaining specified levels of environmental cleanliness. Facilities operated at high contamination levels are considered to be controlled areas or white rooms and, as such, are not within the scope of this document.

National Aeronautics and Space Administration, Manned Spacecraft Center, Houston, Texas. CLEANLINESS OF NON AIRBORNE BREATHING SYSTEMS, SPECIFICATION FOR. 9 Jun. 1967, 4 p. (MSC-SPEC-C-9A).

This specification establishes the minimum contamination control requirements for the permanently installed portions of non airborne breathing systems.

National Aeronautics and Space Administration, Manned Spacecraft Center, Houston, Texas. DEFINITIONS FOR CONTAMINATION PROGRAMS. Aug. 1966, 14 p. (MSC-STD-C-1).

Gives definitions for terms used in spacecraft contamination control.

National Aeronautics and Space Administration, Manned Spacecraft Center, Houston, Texas. GARMENTS, CLEAN-ROOM, SPECIFICATION FOR. Sep. 1966, 7 p. (MSC-SPEC-C-2A).

This specification establishes the requirements for materials construction features, laundering processes, and controls for cleanroom garments and accessories.

National Aeronautics and Space Administration, Manned Spacecraft Center, Houston, Texas. PRECISION CLEAN PACKAGING, SPECIFICATION FOR. Mar. 1967, 11 p. (MSC-SPEC-C-12A).

This specification establishes the procedures and materials to be used for the preservation, packaging, and packing requirements for spacecraft precision-cleaned items.

Specifications and Standards (continued)

National Aeronautics and Space Administration, Manned Spacecraft Center, Houston, Texas. PRECISION CLEANING, SPECIFICATION FOR. 9 Jun. 1967, 11 p. (MSC-SPEC-C-11A).

"This specification describes general methods of cleaning spacecraft systems and components. The constraints implied by cleaning and techniques of cleaning are covered." Author

National Aeronautics and Space Administration, Manned Spacecraft Center, Houston, Texas. PRESSURE GARMENT ASSEMBLY CLEANLINESS, SPECIFICATION FOR. 13 Oct. 1966, 5 p. (MSC-SPEC-C-15).

This specification establishes minimum cleanliness requirements for pressure garment assemblies, garment accessories, attachments, and on-board garment storage containers. The suit interior cleanliness requiements and the permissible contaminant tolerances must be compatible with the cleanliness level of the interfacing fluid system and the exterior of the suit with the cabin cleanliness requirements.

National Aeronautics and Space Administration, Manned Spacecraft Center, Houston, Texas. SYSTEMS CONTAMINATINATION CONTROL DURING REPAIR, REPLACEMENT OR MAINTENANCE, SPECIFICATION FOR. 9 Nov. 1966, 5 p. (MSC-SPEC-C-10).

The cleanliness of precision-cleaned contaminant critical systems can be compromised by improper contamination control techniques during any operation in which the system is opened to uncontrolled environment. This specification establishes the minimum contamination control requirements for repair, replacement, or maintenance operations performed on an installed APOLLO spacecraft fluid system which had previously been precision cleaned.

Society of Automotive Engineers, Inc. AEROSPACE RECOMMENDED PRACTICE. PROCEDURE FOR THE DETERMINATION OF PARTICULATE CONTAMINATION OF AIR IN DUST CONTROLLED SPACES BY THE PARTICLE COUNT METHOD. 15 Jul. 1966, 7 p., diagrs. (ARP 743A).

This method describes the procedure for (1) sampling air in contamination-controlled spaces for airborne particulate contamination 5.0 microns or greater, and (2) determining the concentration and size range distribution of the microscopic particulate material removed from the air sample.